GPH13/DPH13 — QUANTUM MECHANICS –I

Time : Three hours   Maximum : 75 marks

SECTION A — (10 × 2 = 20 marks)

Answer ALL the questions.

1. State the Max Born's interpretation of wave function.

2. Find the expectation value $\langle x \rangle$ of the position of a particle trapped in a box L wide.

3. What is Dirac notation?

4. Write about commuting operators with example.

5. State the difference between schrodinger picture and Heisenberg picture.

6. Define zero point energy of a simple harmonic oscillator.

7. Write a note on parity.

8. What are the properties of density matrices?

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9. Show that $[L_x, L_y] = i\hbar L_z$.

10. State Wigner – Eckart theorem.

SECTION B — (5 × 5 = 25 marks)

Answer ALL the questions.

11. (a) Obtain the continuity equation and show that the probability is conserved.

Or

(b) Derive the time independent schrodinger equation of a particle.

12. (a) Elucidate the postulates of quantum mechanics.

Or

(b) Prove that $[x, P_x] = i\hbar$ remains unchanged under unitary transformation.

13. (a) Deduce Heisenberg equation of motion.

Or

(b) Write about the symmetries and conservation laws in quantum mechanics.

14. (a) What is spatial translation? Explain.

Or

(b) Discuss about time evolution.

15. (a) What are ladder operators? Deduce their commutation relation.

Or

(b) Derive Clebsh-Gordan coefficients.

SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions of the following.

16. Describe the motion of a particle inside a square well potential.

17. State and prove Ehrenfest theorem.

18. Find the energy of a simple harmonic oscillator by the operator method.

19. Obtain the Schrodinger equation for the hydrogen atom and seperate it into radial and angular part.

20. Obtain the matrices of ladder operators for $j = 1$ sate.

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